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SUBMISSION OF ENGLISH LANGUAGE TRANSLATION OF JAPANESE PATENT APPLICATION LAID-OPEN No. 10-247411

MAIL STOP - Amendments
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Attached hereto is a copy of an English language translation of Japanese Patent Application Laid-Open No. 10-247411, published September 14, 1998, which was cited by Applicant in the Information Disclosure Statement filed April 11, 2005. Applicant requests that the Examiner include this English language translation in his consideration of cited Japanese Patent Application Laid-Open No. 10-247411.

The Commissioner is hereby authorized to charge any fees which may be required for filing this paper to Deposit Account No. 13-4500, Order No. 1232-4719.

Respectfully submitted,

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(54) [Title of the Invention]

SURFACE LIGHT SOURCE APPARATUS

(57) [Abstract]

[Problem to be solved]

A surface light source apparatus is to be enabled to obtain a satisfactory white light, free from coloring, by combining a plurality of luminous bodies having different luminous frequencies.

[Solution]

LED chips 18R, 18G and 18B whose luminous colors are red, green and blue are arranged close to one another over a circuit board 15 and sealed with a transparent resin 19 to form a luminous body group 16. The LED chips 18R, 18G and 18B of the luminous body group 16 emit a red light, a green light and a blue

light from mutually close positions, and the emitted red light, green light and blue light become mixed by being reflected/refracted by the interface of a transparent resin 19, and emitted as a white light from the luminous body group 16 to a light guide plate 12.

[Claims]

[Claim 1]

A surface light source apparatus provided with a light guide plate for emitting light from one main face and a light emitting element positioned opposite one end face of the light guide plate,

the surface light source apparatus being characterized in that said light emitting element has a luminous body group formed by arranging a plurality of luminous bodies differing in luminous wavelength close to one another.

[Claim 2]

The surface light source apparatus according to Claim 1, characterized in that said light emitting element has a plurality of said luminous body groups.

[Claim 3]

The surface light source apparatus according to Claim 1, characterized in that reflective walls are formed on two sides of said luminous body group.

[Claim 4]

The surface light source apparatus according to Claim 1, characterized in that said luminous body group is sealed with resin.

[Claim 5]

The surface light source apparatus according to Claim 1, characterized in that a light diffusion

pattern is formed, opposite said luminous body group, on an end face of the light guide plate.

[Claim 6]

The surface light source apparatus according to Claim 1, characterized in that the overall luminous power of luminous bodies of the same wavelength making up said luminous body group is substantially equal for every wavelength.

[Claim 7]

The surface light source apparatus according to Claim 1, characterized in that luminous bodies making up said luminous body group are arranged symmetrically for each wavelength.

[Claim 8]

The surface light source apparatus according to Claim 1, characterized in that luminous bodies of the same wavelength making up said luminous body group are so arranged that spaces between the luminous bodies be substantially equal.

[Claim 9]

A surface light source apparatus provided with a light guide plate for letting in light from one end face and emitting light from one main face and a plurality of luminous bodies having different luminous frequencies, wherein the luminous bodies are dispersedly arranged opposite said end face of the light guide plate,

the surface light source apparatus being characterized in that the overall luminous power of luminous bodies of the same wavelength is substantially equal for every wavelength.

[Claim 10]

A surface light source apparatus provided with a light guide plate for letting in light from one end face and emitting light from one main face and a plurality of luminous bodies having different luminous frequencies, wherein the luminous bodies are dispersedly arranged opposite said end face of the light guide plate,

the surface light source apparatus being characterized in that luminous bodies having different wavelengths are arranged to be substantially uniform with priority given to luminous bodies whose number of units is smaller.

[Claim 11]

The surface light source apparatus according to Claim 9, characterized in that power consumption of luminous bodies when in use is so adjusted that the overall luminous power of luminous bodies of the same wavelength be substantially equal for every wavelength.

[Claim 12]

The surface light source apparatus according to Claim 9 or 10, characterized in that light diffusing means having a high diffusion effect is disposed

opposite a luminous body of which the number of light sources is relatively small and the luminous energy is large and light diffusing means having a low diffusion effect is disposed opposite a luminous body of which the number of light sources is relatively large and the luminous energy is small.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a surface light source apparatus. More particularly, it relates to a surface light source apparatus using a light emitting element provided with a luminous body group consisting of light emitting diodes of three colors including red (R), green (G) and blue (B).

[0002]

[Prior art]

In a surface light source apparatus provided with a monochrome luminous body, a light emitting element having a plurality of monochrome (e.g. green) light emitting diode (hereinafter referred to as LED) chips mounted over a circuit board is positioned opposite an end face (the light incidence end face) of a light guide plate.

[0003]

A surface light source apparatus for use in color liquid crystal display devices is configured in a

similar way to this and, as shown in Figure 1, LED chips 3R, 3G and 3B of three colors including red (R), green (G) and blue (B) are arrayed along a circuit board 2 to constitute a light emitting element 1. And this light emitting element 1 is arranged opposite the light incidence end face 5 of a light guide plate 4.

[0004]

However, where such a light emitting element was used, there was a problem that the light emitted from the light emission face was hued with rainbow colors in the vicinity of the light incidence end face of the light guide plate. Thus in the vicinity of the light emitting element, as the three colors of red, green and blue were not uniformly mixed, separate coloring with red, green and blue occurred immediately before the LED chips of the respective colors, red, green and blue, mixed coloring arose between them, and no white light could be obtained until some distance was attained away from the light incidence end face. As a result, where a liquid crystal display device was configured by superposing a liquid crystal display panel for color use over a surface light source apparatus, there was a problem that the image on the liquid crystal display panel was colored in end parts. Or if the coloring of the image was to be prevented, it was necessary to avoid the use of the vicinity of the light incidence end face of the surface light source element, resulting

in a drop in the utilization efficiency of the surface light source apparatus and entailing a problem that the surface light source apparatus tended to become large in comparison with the required light emitting area.

[0005]

[Problems to be Solved by the Invention]

The present invention has been attempted in view of the above-described shortcomings of the prior art, and its object is to provide a surface light source apparatus using a light emitting element capable of obtaining a satisfactory white light, free from coloring, by combining a plurality of luminous bodies having different luminous frequencies.

[0006]

[Disclosure of the Invention]

The surface light source apparatus stated in Claim 1 is provided with a light guide plate for emitting light from one main face and a light emitting element positioned opposite one end face of the light guide plate, the surface light source apparatus being characterized in that the light emitting element has a luminous body group formed by arranging a plurality of luminous bodies differing in luminous wavelength close to one another.

[0007]

While the surface light source apparatus according to the prior art mixes within a light guide plate

lights of wavelengths emitted from the luminous bodies to generate a white light, luminous bodies differing in luminous wavelength are arranged close to one another to form a luminous body group in the surface light source apparatus according to Claim 1, and the luminous body groups mix lights of different wavelengths and emit the resultant white light toward the light guide plate.

[0008]

Therefore, coloring of lights emitted from the light guide plate at the light incidence end face of the light guide plate can be substantially reduced to make available a satisfactory white light.

[0009]

In particular, by providing a plurality of luminous body groups, it is made possible to obtain a light emitting element which is similar to an arrangement of a plurality of white dot light sources and, even if the light guide plate is large, a white light can be emitted without being colored.

[0010]

Also, fluctuations in the luminance angle distribution of lights coming incident on the light guide plate can be reduced by forming reflective walls on two sides of luminous body group, sealing the luminous body group with resin or forming a light

diffusion pattern, opposite the luminous body group, on an end face of the light guide plate.

[0011]

Further, substantially equalizing the overall luminous power of luminous bodies of the same wavelength making up the luminous body group for every wavelength, fluctuations in luminance among the luminous bodies can be adjusted to obtain a satisfactory white light as a whole.

[0012]

Also, by so arranging luminous bodies making up the luminous body group symmetrically for each wavelength, the optical wavelength distribution is made symmetric, and a white light of satisfactory optical characteristics can be obtained.

[0013]

Further, by so arranging luminous bodies of the same wavelength making up the luminous body group that spaces between the luminous bodies be substantially equal, luminance unevenness among different wavelengths are eliminated to further reduce the coloring of the white light.

[0014]

The surface light source apparatus stated in Claim 9 comprises a light guide plate for letting in light from one end face and emitting light from one main face and a plurality of luminous bodies having different

luminous frequencies, wherein the luminous bodies are dispersedly arranged opposite the end face of the light guide plate, and is characterized in that the overall luminous power of luminous bodies of the same wavelength is substantially equal for every wavelength.

[0015]

For instance, otherwise than adjusting the number of luminous bodies, power consumption of luminous bodies when in use can be so adjusted that the overall luminous power of luminous bodies of the same wavelength be substantially equal for every wavelength.

[0016]

Also where a plurality of luminous bodies having different luminous frequencies are dispersedly arranged along the light guide plate, the levels of luminous energy emitted from luminous bodies of each wavelength are substantially equalized to reduce the coloring of the white light by substantially equalizing the overall luminous power of luminous bodies of each wavelength.

[0017]

The surface light source apparatus stated in Claim 10 comprises a light guide plate for letting in light from one end face and emitting light from one main face and a plurality of luminous bodies having different luminous frequencies, wherein the luminous bodies are dispersedly arranged opposite the end face of the light guide plate, and is characterized in that luminous

bodies having different wavelengths are arranged to be substantially uniform with priority given to luminous bodies whose number of units is smaller.

[0018]

In this surface light source apparatus, since luminous bodies having different wavelengths are arranged to be substantially uniform with priority given to luminous bodies whose number of units is smaller, the lights of different luminous wavelengths can be reasonably equalized to enable color fluctuations to be easily eliminated.

[0019]

Since characteristics of elements can be compensated for by disposing light diffusing means having a high diffusion effect opposite a luminous body of which the number of light sources is relatively small and the luminous energy is large and light diffusing means having a low diffusion effect opposite a luminous body of which the number of light sources is relatively large and the luminous energy is small, a white light source with little coloring can be made available.

[0020]

[Embodiments of the Invention]

Figure 2 is a plan showing a surface light source apparatus 11 in one mode of implementing the present invention. On the under face of a light guide plate 12

consisting of a transparent resin material with a high refractive index such as polycarbonate resin or methacrylate resin, there is formed a diffusion pattern (not shown), formed by surface roughing, dot printing with diffusion ink or otherwise, in appropriate densities and varying densities. The light emitting element 14 is positioned opposite the light incidence end face 13 of the light guide plate 12. This light emitting element 14 comprises a plurality of luminous bodies groups16 formed at appropriate intervals on the front face of a circuit board 15, and an arciform concave 17 is formed opposite the light incidence end face 13 of the light guide plate 12. On under face of this light guide plate 12, there is arranged a reflective sheet (not shown) for preventing losses due to light leaks.

[0021]

One of these luminous body groups 16 is shown in Figure 3. The luminous body group 16 is composed by mounting on the circuit board 15 an LED chip 18R emitting a light of red (R) color, an LED chip 18G emitting a light of green (G) color, and an LED chip 18B emitting a light of blue (B), the three being positioned close to one another, and sealed with transparent resin 19. However, when the LED chips 18R, 18G and 18B of the luminous body group 16 emit lights, a white light is emitted from the luminous body group

16 since the LED chips 18R, 18G and 18B are arranged close to one another in the luminous body group 16. A white light emerging from this luminous body group 16 enters into the light guide plate 12 through the light incidence end face 13 of the light guide plate 12. The light then entering through the concave 17 into the light guide plate 12 is expanded by being refracted in the lateral direction as well by the curve of the concave 17 as shown in Figure 3, and uniformly expands within the whole light guide plate 12. The light having entered into the light guide plate 12 is totally reflected by the inner face of the light guide plate 12 and at the same time scattered in a diffusing pattern and, when the angle of incidence on the light emitting face 20 (upper face) of the light guide plate 12 becomes small than the critical angle of the total reflection, is emitted from the light emitting face 20. [0022]

Therefore, in this surface light source apparatus 11, since a white light generated by mixture of red, green and blue lights is emitted from the respective luminous body group 16, the light emitting element 14 can be used as the source of the white light, and the coloring of the light coming out of the light emission face 20 of the light guide plate 12 is reduced even in the vicinity of the light incidence end face 13. In particular, as the three LED chips 18R, 18G and 18B of

this luminous body group 16 are wrapped by the transparent resin 19, the red light, green light and blue light respectively emitted from the LED chips 18R, 18G and 18B are mixed while repeating refraction and reflection by the interface of the transparent resin 19. If the three LED chips 18R, 18G and 18B were simply arrayed, the luminance angle distribution (luminance angle distribution of the lights coming incidence on the light guide plate) would vary with the color differences among the lights coming incident on the light guide plate 12, but the mixing of the lights of different colors by the transparent resin 19 results in reduced differences in the luminance angle distribution of lights coming incident on the light guide plate, making available a more uniformized white light source.

[0023]

Therefore, the surface light source apparatus 11 using the light emitting element 14 according to the invention can be used as a satisfactory white surface light source having a uniform luminance distribution free from coloring even on the light incidence end face 13.

[0024]

(Second through fifth modes of implementation) Also, in order to prevent the luminance angle distribution of lights coming incident on the light guide plate from one to another of the LED chips

differing in luminous color, various structures described below can be used.

[0025]

The luminous body group 16 shown in Figure 5 is provided with reflective walls 21 on two sides, left and right, of the three LED chips 18R, 18G and 18B sealed by the transparent resin 19. By disposing the reflective walls 21 on the two sides, the lights emitted from the LED chips 18R, 18G and 18B are caused to be reflected by the reflective walls 21 to change their angles, and the resultant mixing and diffusion of the lights differing in color makes available a white light source and at the same time reduces differences in the luminance angle distribution of lights coming incident on the light guide plate.

[0026]

The luminous body group 16 shown in Figure 6 has reflective walls 21 on two sides, left and right, of the three LED chips, and the LED chips 18R, 18G and 18B and the reflective walls 21 are sealed the transparent resin 19. In this mode of implementation too, by disposing the reflective walls 21 on the two sides, the lights emitted from the LED chips 18R, 18G and 18B are caused to be reflected by the reflective walls 21 to change their angles, and the resultant mixing and diffusion of the lights differing in color makes available a white light source and at the same time

reduces differences in the luminance angle distribution of lights coming incident on the light guide plate.

[0027]

The luminous body group 16 shown in Figure 7 has reflective walls 21 on two sides of, above and underneath, the three LED chips 18R, 18G and 18B sealed by the transparent resin 19. By disposing the reflective walls 21 above and underneath, the lights emitted from the LED chips 18R, 18G and 18B are caused to be reflected by the reflective walls 21 to change their angles, and the resultant mixing and diffusion of the lights differing in color makes available a white light source and at the same time reduces differences in the luminance angle distribution of lights coming incident on the light guide plate.

[0028]

Another mode of implementation shown in Figure 8 has a light diffusion pattern 22 consisting of random ruggedness or a prescribed pattern of ruggedness in the concave 17 of the light guide plate 12. In this mode of implementation, as the lights emitted from the LED chips 18R, 18G and 18B, when coming incident into the light guide plate 12 from the concave 17, enter into the light guide plate 12 in irregular direction while being scattered by the light diffusion pattern 22, the luminance distribution of the lights can be more uniformized and, at the same time, differences in the

luminance angle distribution of lights coming incident on the light guide plate can be reduced.

[0029]

(Sixth mode of implementation) Figure 9 (a) shows one of the luminous body groups 16 of the light emitting element 14 in still another mode of implementing the invention. In this luminous body group 16, a plurality of sets of LED chips 18R, 18G and 18B of different colors are arrayed on a plurality of levels over the circuit board 15, and the LED chips 18R, 18G and 18B are sealed by the transparent resin 19. Where the LED chips 18R, 18G and 18B are arrayed on a plurality of levels, the overall width of the LED chips 18R, 18G and 18B is narrowed in the view of the light emitting element 14 from above, and accordingly fluctuations in the luminance angle distribution of lights coming incident on the light guide plate due to the way of arraying the LED chips 18R, 18G and 18B differing in luminous color can be reduced.

[0030]

In particular it is desirable for the arrangements of luminous colors to be reverse to each on the upper and lower levels as shown in Figure 9 (b). The reversal of the arraying order proves even more effective in making available a white light source and reducing fluctuations in the luminance angle

distribution of lights coming incident on the light guide plate.

[0031]

(Seventh and eighth modes of implementation) In any of the modes of implementation described above, equal numbers of red LED chips, green LED chips and blue LED chips are used. However, the luminous power of an LED chip differs with the efficiency, maximum rating and other factors of the element, and the ratio among the respective maximum luminous powers P_R, P_G and P_B of the red LED chips, green LED chips and blue LED chips is approximately:

$$P_R:P_G:P_B = 8:1:4$$

Therefore, it is desirable for the numbers of LED chips 18R, 18G and 18B of different colors used in each of the luminous body groups 16 of the light emitting element 14 to be in a ratio of one for the red LED chips 18R, 8 for the green LED chips 18G and 4 for the blue LED chips 18B and thereby to equalize the luminous powers of the different colors.

[0032]

However, if for instance one red LED chip 18R [represented by simply R in the drawing], 8 green LED chips 18G [represented by simply G in the drawing] and 4 blue LED chips 18B [represented by simply B in the drawing] are merely arrayed as shown in Figure 10, colors will differ between left and right. To array

these LED chips 18R, 18G and 18B, first, LED chips (red) 18R, which are the smallest in number, are allocated to be uniform in the area of arrangement, then LED chips (blue) 18B, the next smallest in number, are allocated to be substantially uniform in vacant positions in the area of arrangement, and finally LED chips (green) 18G, the largest in number, are allocated in still vacant positions as shown in Figure 11.

[0033]

Further, in order to more uniformize the lights emitted from the LED chips 18R, 18G and 18B, the LED chips 18R, 18G and 18B of different colors can as well be arrayed uniformly in the area of arrangement, and arrayed in a single row as they are as shown in Figure 12.

[0034]

Since the LED chips 18R, 18G and 18B are arrayed symmetrically between left and right both in the arrangement of Figure 11 and in the arrangement of Figure 12 and further the spaces between the LED chips 18R, 18G and 18B are made constant in the arrangement of Figure 11, mounting of the LED chips 18R, 18G and 18B onto the circuit board 15 is facilitated; in the arrangement shown in Figure 12, the luminous powers of different colors are made more uniform, contributing to making available a white light source.

[0035]

Incidentally, though not illustrated, it also is an effective way not to drive the LED chips 18R, 18G and 18B of different colors at their maximum rating and but to keep power consumption at the time of using the LED chips 18R, 18G and 18B at a ratio of about 1:2:8 among the red LED chips 18R, green LED chips 18G and blue LED chips 18B.

[0036]

(Ninth mode of implementation) While the modes of implementation so far described were to make available a white light source by arranging the LED chips 18R, 18G and 18B of different colors close to one another to constitute a luminous body group 16, what is shown in Figure 13 is to enable the surface light source apparatus to provide a white line by arranging the LED chips 18R, 18G and 18B of different colors along the light incidence end face 13 of the light guide plate 12.

[0037]

Thus, what is shown in Figure 13 utilizes the arrangement of the LED chips 18R, 18G and 18B determined by taking account of the luminous power ratio among the LED chips 18R, 18G and 18B of different colors as in the seventh mode of implementation (Figure 11). Although the LED chips 18R, 18G and 18B were arranged within the luminous body group 16 in the seventh mode of implementation, the arrangement is used for arraying the LED chips 18R, 18G and 18B along the

light incidence end face 13 of the light guide plate 12 in this mode of implementation.

[0038]

Where the LED chips 18R, 18G and 18B of different colors are arranged in such a way along the light incidence end face of the light guide plate 12, the overall color balance is improved also to make available a satisfactory white light source, and the coloring on the light emission face 20 of the light guide plate 12 can be reduced.

[0039]

(10th mode of implementation) Further, in what is shown in Figure 14, though the spaces between the LED chips 18R, 18G and 18B of different colors are uneven as in the eighth mode of implementation, those between the LED chips of each color are uniformized (see Figure 12).

[0040]

Also where the LED chips 18R, 18G and 18B of different colors are arranged in such a way along the light incidence end face 13 of the light guide plate 12, the overall color balance is improved to make available a satisfactory white light source, and the coloring on the light emission face 20 of the light guide plate 12 can be reduced.

[0041]

Incidentally, if in a position opposite LED chips 18R, 18G or 18B a concave 17 is provided in the light incidence end face 13 of the light guide plate 12 as shown in Figure 15 or a light diffusion pattern 22 is formed as shown in Figure 16, the lights of different colors coming incident on the light guide plate 12 can be expanded left to right within the light guide plate 12 and thereby distributed uniformly within the light guide plate 12.

[0042]

(11th mode of implementation) Figure 17 is a plan showing a surface light source apparatus in yet another mode of implementing the invention. In this mode of implementation, one red LED chip 18R, two blue LED chips 18B and eight green LED chips 18G [the LED chips 18R, 18G and 18B are represented by simply R, G and B in Figure 17] are disposed in the same arrangement as in Figure 16 opposite the light incidence end face 13 of the light guide plate 12. Of this light incidence end face 13 opposite which the LED chips 18R, 18G and 18B are arranged, a deep concave 17R shown in (a) and (b) of Figure 18 is provided in the position opposite the red LED chip 18R, a shallow concave 17G shown in (a) and (b) of Figure 19 is provided in the position opposite the green LED chips 18G, and a medium-depth concave 17B is provided in the position opposite the blue chips 18B.

[0043]

As shown in (a) and (b) of Figure 18, in the deep concave 17R, though the effect to diffuse the light coming incident on the light guide plate 12 increases, the coupling efficiency between the LED chip and the light guide plate 12 decreases because luminous energy leaking obliquely upward and downward from the space of the concave 17R increases. Conversely as shown in (a) and (b) of Figure 19, in the shallow concave 17G, though the effect to diffuse the light coming incident on the light guide plate 12 decreases, the coupling efficiency between the LED chips and the light guide plate 12 increases. As the red LED chip 18R is higher in the efficiency of coupling with the light guide plate 12 and smaller in the number of units used, the concave to match the red LED chip 18R is made deeper (17R); as the green LED chips 18G are lower in the efficiency of coupling with the light guide plate 12 and greater in the number of units used, the concave to match the green LED chips 18G is made shallower (17G); and as the blue LED chips 18B are lower in the efficiency of coupling with the light guide plate 12 and greater in the number of units used, the concave to match the blue LED chips 18B is given a medium depth (17b): the optical coupling efficiencies of the LED chips 18R, 18G and 18B are thereby balanced, and the extents of light diffusion can be thereby uniformized,

making it possible to obtain a white surface light source of high luminance and uniform in luminance distribution.

[0044]

(Liquid crystal display device) Figure 20 is an exploded perspective view of a liquid crystal display device 81 using a surface light source apparatus 80 according to the invention. In front of the surface light source apparatus 80, a diffusion reflective sheet 82 is arranged, and on its front face a liquid crystal display panel 83 is disposed. The liquid crystal display panel 83 is formed by sealing a liquid crystal material between two liquid crystal substrates 84 and 85 (glass substrates or film substrates) over which a transparent electrode, TFT, color filter, black matrix and so forth are formed, and polarizing plates 86 are disposed over the two outer faces of the liquid crystal substrates 84 and 85.

[0045]

(Electronic apparatus equipped with liquid crystal display device) The liquid crystal display device according to the invention can be suitably used in wireless communication apparatuses, such as mobile telephones and low power radio sets, and in information processing apparatuses, such as mobile personal computers, electronic notebooks and electronic calculators. Figure 21 is a perspective view of a

mobile telephone 89 provided with the liquid crystal display device 81 according to the invention for display use, for instance what is shown in Figure 20; and Figure 22, its functional block diagram. The mobile telephone 89 is provided on its front face with button switches 90, such as numeric keys, for dialing use, and above it the liquid crystal display device 81 is disposed, with an antenna 91 arranged at the top. And, when dialing information or the like is inputted from the button switches 90, the inputted dialing information or the like is transmitted through a transmitting circuit 92 from an antenna 91 to a base station of the telephone company. On the other hand, the inputted dialing information or the like is sent to a liquid crystal driving circuit 93, and the liquid crystal display device 81 is driven by the liquid crystal driving circuit 93 to display the dialing information or the like on the liquid crystal display device 81.

[0046]

Further, Figure 23 is a perspective view of a mobile information terminal device 94, such as an electronic notebook or a mobile personal computer, provided with the liquid crystal display device 81 according to the invention for display use, for instance what is shown in Figure 20; and Figure 24, its functional block diagram. The mobile information

terminal device 94, when its cover 95 is opened, a key input unit 96 and the liquid crystal display device 81 are found disposed, and the liquid crystal driving circuit 93, an arithmetic processing circuit 97 and the like are provided inside. And when inputting is done with numeric keys or Japanese letter keys for instance by means of the key input unit 96, the input information is delivered to the liquid crystal driving circuit 93 and displayed on the liquid crystal display device 81. Then, when a control key, such as a computation key or the like, pressed, the arithmetic processing circuit 97 performs prescribed processing or computation, whose result is delivered to the liquid crystal driving circuit 93 and displayed on the liquid crystal display device 81.

[0047]

Incidentally, though the LED chips or the luminous body groups are formed over the circuit board in the light emitting elements in the above-described modes of implementation, they may as well be light emitting elements of a lead-mounted type.

[Brief Description of the Drawings]

[Figure 1]

This is a schematic plan showing a surface light source apparatus according to the prior art.

[Figure 2]

This is a plan showing a surface light source apparatus in one mode of implementing the present invention.

[Figure 3]

This is a diagram illustrating the actions of the above.

[Figure 4]

This is a diagram illustrating the actions of the above.

[Figure 5]

This is a schematic diagram showing a luminous body group in another mode of implementing the invention.

[Figure 6]

This is a schematic diagram showing a luminous body group in still another mode of implementing the invention.

[Figure 7]

This is a perspective view showing a luminous body group in yet another mode of implementing the invention.

[Figure 8]

This is a schematic diagram showing a luminous body group and a concave portion in a light guide plate in still another mode of implementing the invention.

[Figure 9]

(a) is a perspective view showing a luminous body group in yet another mode of implementing the invention,

and (b), a diagram showing the arrangement of LED chips in the luminous body group.

[Figure 10]

This is a diagram showing one example of arraying LED chips in three colors.

[Figure 11]

This is a diagram showing a preferable way of arraying LED chips.

[Figure 12]

This is a diagram showing a preferable way of arraying LED chips.

[Figure 13]

This is a diagram showing a way of arraying LED chips in a surface light source apparatus in still another mode of implementing the invention.

[Figure 14]

This is a diagram showing a way of arraying LED chips in a surface light source apparatus in still another mode of implementing the invention.

[Figure 15]

This is a plan showing a partially broken view of a surface light source apparatus in yet another mode of implementing the invention.

[Figure 16]

This is a plan showing a partially broken view of a surface light source apparatus in still another mode of implementing the invention.

[Figure 17]

This is a schematic plan showing a surface light source apparatus in still another mode of implementing the invention.

[Figure 18]

(a)(b) are diagrams illustrating the actions of the above.

[Figure 19]

(a)(b) are diagrams illustrating the actions of the above.

[Figure 20]

This is an exploded perspective view of a liquid crystal display device using a surface light source apparatus according to the invention.

[Figure 21]

This is a perspective view of a mobile telephone provided with a liquid crystal display device according to the invention for display use.

[Figure 22]

This is a block diagram showing a configuration for driving the liquid crystal display device in the foregoing mobile telephone.

[Figure 23]

This is a perspective view of a mobile information terminal device, such as an electronic notebook, provided with a liquid crystal display device according to the invention for display use.

[Figure 24]

This is a block diagram shown the configuration for driving the liquid crystal display device in the mobile information terminal device.

[Description of Symbols]

12 Light guide plate

13 Light incidence end face

14 Light emitting element

15 Circuit board

16 Luminous body group

18R, 18G and 18B LED chips

19 Transparent resin

21 Reflective wall

22 Light diffusion pattern

Figure 22

81 Liquid crystal display device

90 Button switches

91 Antenna

92 Transmitting circuit

93 Liquid crystal driving circuit

Figure 24

81 Liquid crystal display device

96 Key input unit

93 Liquid crystal driving circuit

97 Arithmetic processing circuit